SCCWRP #810

Anthropogenic nutrient sources rival natural sources on small scales in the coastal waters of the Southern California Bight

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ABSTRACT

Anthropogenic nutrients have been shown to provide significant sources of nitrogen (N) that have been linked to increased primary production and harmful algal blooms worldwide. There is a general perception that in upwelling regions, the flux of anthropogenic nutrient inputs is small relative to upwelling flux, and therefore anthropogenic inputs have relatively little effect on the productivity of coastal waters. To test the hypothesis that natural sources (e.g., upwelling) greatly exceed anthropogenic nutrient sources to the Southern California Bight (SCB), this study compared the source contributions of N from four major nutrient sources: (1) upwelling, (2) treated wastewater effluent discharged to ocean outfalls, (3) riverine runoff, and (4) atmospheric deposition. This comparison was made using large regional data sets combined with modeling on both regional and local scales. At the regional bight-wide spatial scale, upwelling was the largest source of N by an order of magnitude to effluent and two orders of magnitude to riverine runoff. However, at smaller spatial scales, more relevant to algal bloom development, natural and anthropogenic contributions were equivalent. In particular, wastewater effluent and upwelling contributed the same quantity of N in several subregions of the SCB. These findings contradict the currently held perception that in upwelling-dominated regions anthropogenic nutrient inputs are negligible, and suggest that anthropogenic nutrients, mainly wastewater effluent, can provide a significant source of nitrogen for nearshore productivity in Southern California coastal waters.